DIPARTIMENTO DI INGEGNERIA CIVILE E ARCHITETTURA
DOTTORATO IN INGEGNERIA CIVILE E ARCHITETTURA
UNIVERSITÀ DEGLI STUDI DI PAVIA

SHORT COURSE ON

THEORETICAL AND COMPUTATIONAL POROMECHANICS

CARLO CALLARI, UNIVERSITÀ DEL MOLISE

JUNE, 22, 23, 24, 25, 26
FROM 14:30 TO 16:30
VIA FERRATA 3, PAVIA

Detailed Outline

MOTIVATIONS: The role of poromechanics in civil, environmental and medical engineering: problem analysis and material modeling

PART 1: Mechanics of fully saturated porous media with compressible phases

Biot's thermodynamics and constitutive equations:

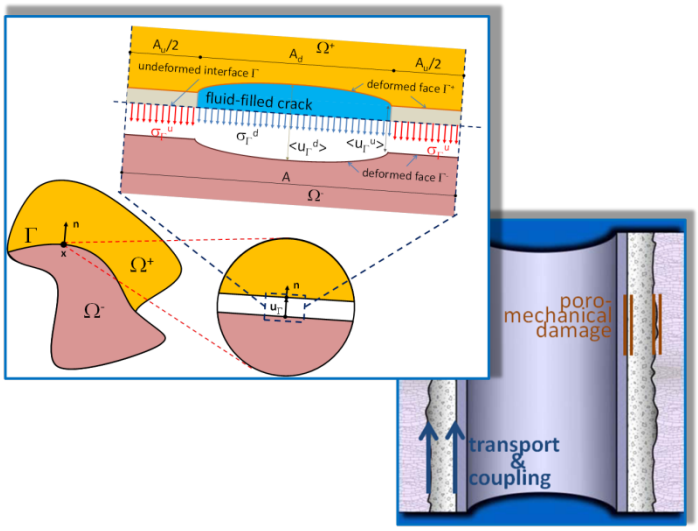
- Thermodynamics of barotropic and inviscid fluids
- Fluid mass balance in the porous medium
- Local forms of first and second principles
- Clausius-Duhem inequality
- Transport laws
- General form of constitutive laws for the porous medium
- Linear poroelasticity and extension to poro-elastoplasticity
- Fluid-to-solid and solid-to-fluid limit uncoupled influences
- Strain-dependent permeability models

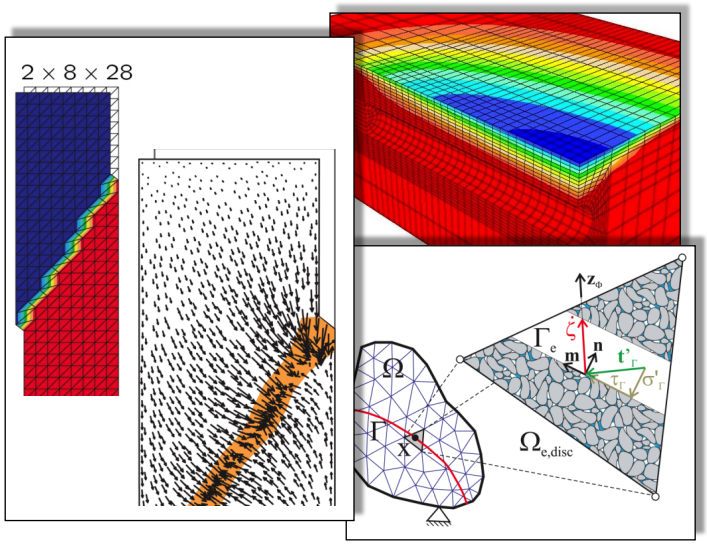
Finite element formulations for porous media:

- Boundary conditions for mechanical and fluid-flow fields
- Formulation of mechanical and fluid-flow problems
- Extension to non-linear response

Research applications to saturated porous media:

- 2D response of dam and rock mass to reservoir operations
- Tunnel face stability
- Poroelastic damage and applications to hydrocarbon wells





PART 2: Extension to multiphase fluids

Biot's thermodynamics and poroelastic laws:

- General hyperelastic laws for three-phase porous media
- Generalized Darcy law
- Constitutive equations from the theory of mixtures
- Characterization of hyperelastic laws
- Possible forms of tangent operators
- Laws based on strain-independent retention models
- Laws based on porosity-dependent retention models

Finite elements for unsaturated porous media:

- Unilateral boundary conditions on unsaturated flow
- Time integration consistent tangents
- Mass-conservative schemes
- Regularization of unilateral boundary conditions
- Permeability model linearization

Research applications to unsaturated porous media:

- Rainfall infiltration
- 3D response of dam and rock mass to reservoir operations
- Strain localization: plane strain compression test, tunnel stability

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